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(54) Loudspeaker magnet system

(57) In conventional commercial loudspeakers having a permanent magnet of the flat ferrite type, the magnet is provided with a central hole and is arranged in the magnet system as an outer cylindrical part about a central rod of soft iron, the voice coil being received in the annular air gap between the rod and the wall of the hole in the flat magnet. The invention provides for an inverted arrangement, in which a flat magnet disc member 4 (with or without, a central hole, and a pole piece 18) is used as the central rod member while the outer cylindrical part 6 is made of soft iron, e.g. integrally with the rear pole plate 2 of the magnetic system. The use of a conventional ferrite magnet conditions a low price and a voice coil 12 of large diameter, whereby the loudspeaker may be driven at high electrical effect due to an effective cooling of the voice coil. The outer annular soft iron member acts as a magnetic shield which makes the loudspeaker substantially free of any exterior magnetic field.

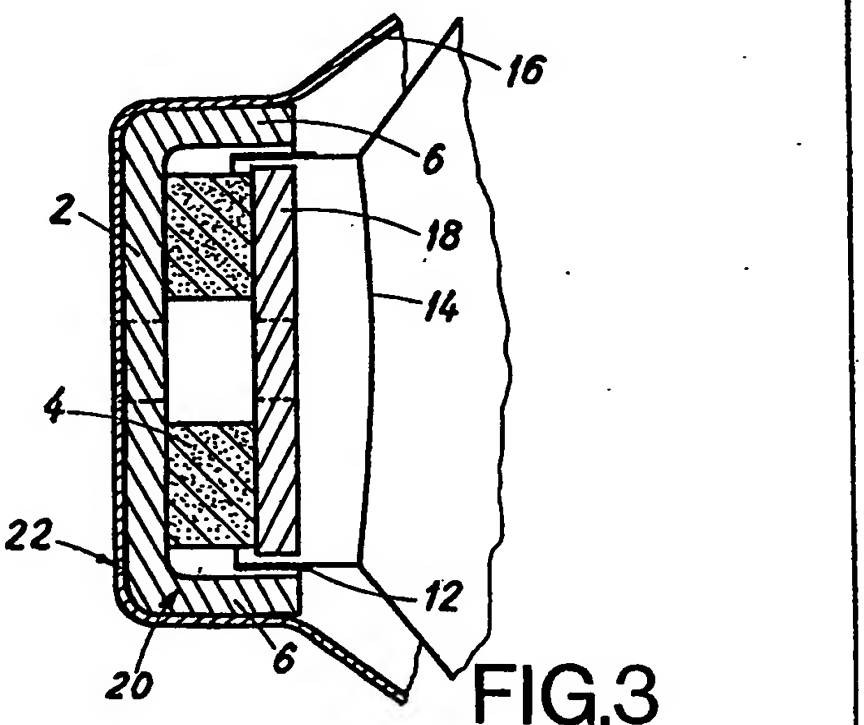

FIG.3

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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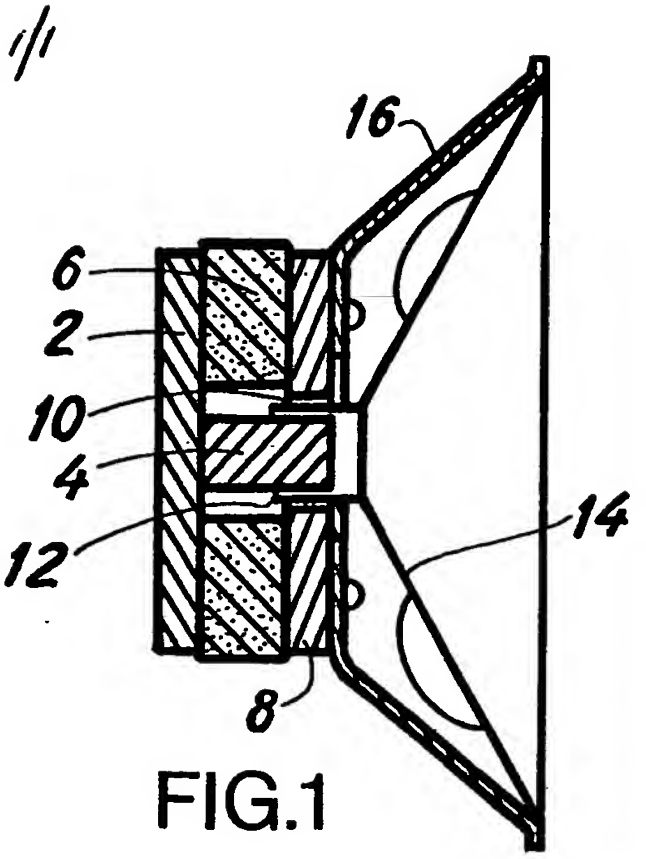

FIG.1

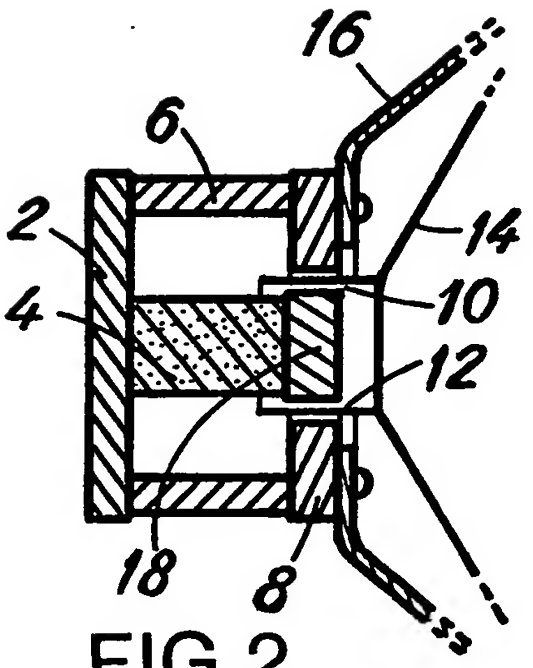

FIG.2

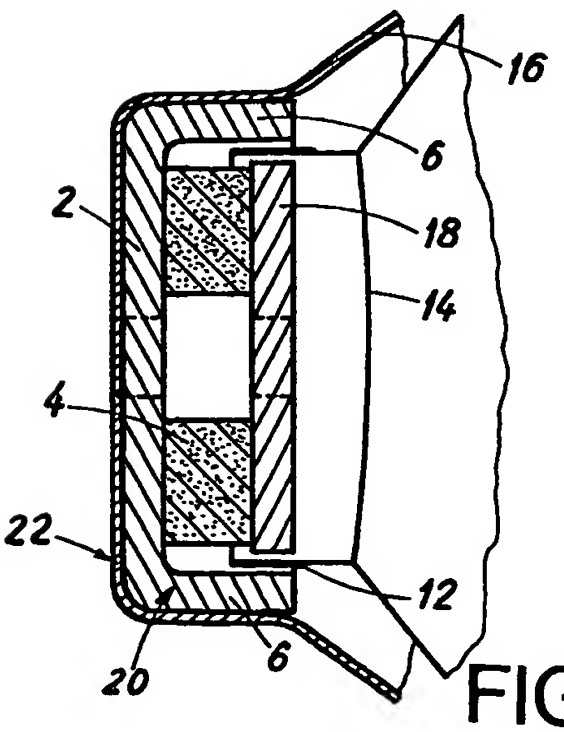

FIG.3

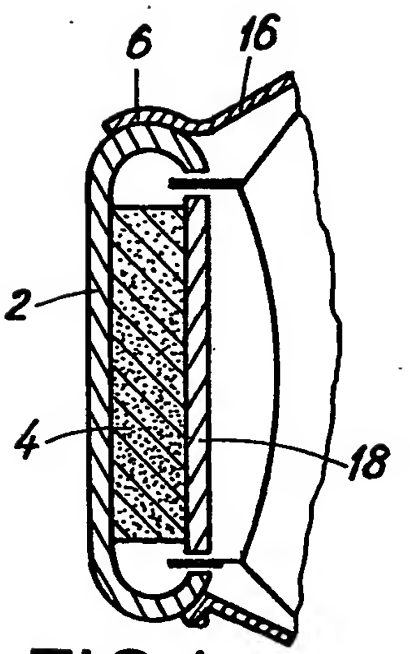

FIG.4

SPECIFICATION
A loudspeaker

The present invention relates to a loudspeaker of the type defined in the introductory clause of claim 1, i.e. a very common loudspeaker type which is produced both as expensive, sophisticated units for professional use and as cheaper standard units for ordinary commercial use. For the latter purpose, with which the invention is particularly concerned, loudspeakers are produced in large quantities practically exclusively based on two different designs of the magnetic system, viz. either one type using a central magnet rod of some high quality alloy material such as "Alnico" or another type in which the permanent magnet is constituted by the cylindric outer element of the system and consist of a magnet material of the so-called ferrite type, normally characterized by a non-homogenous material structure comprising magnetically active particles held together in a moulded pressed or sintered magnet body. These two basic types of magnet systems can be briefly described as follows:

1. Systems having a central alloy magnet:
The magnet material is rather expensive, but can be used with a relatively small volume because of its being shaped as a rod used as the central element, i.e. having a diameter smaller than the diameter of the voice coil. Magnetically the material is particularly well suited to form a rod shaped magnet since for a given rod diameter the achievable magnetic strength will simply increase for an increasing length of the rod. Normally, therefore, the length of the rod is larger than its diameter, and for showing the desired high magnetic strength the rod, normally, is even longer than would be structurally necessary for allowing the voice coil to carry out oscillations of maximum amplitude in the air gap adjacent the front end of the rod magnet. The cylindric outer element of the magnet system is constituted by a cylindric member of soft iron just serving to close the magnetic circuit between the rear end of the rod magnet and an outer pole piece about the voice coil. This cylinder outer element is thus made of a cheap material, and since it does not show any considerable magnetic permanence it will additionally form an outer magnetic shield of the system, such that the magnetic system will be practically without any exterior magnetic field. This is an important advantage when the loudspeaker should be used e.g. in a television receiver, in which any free magnetic field will normally cause operational troubles or require special shielding.

2. Systems having a ring magnet of the ferrite type:
These magnets are not expensive, and the magnet material is particularly well suited to be shaped as a flat annular disc member for mounting about the voice coil as the outer cylindric element of the magnet system. Based on a given usable thickness of the annular disc member an increase of the magnetic strength is only to a small degree obtainable by increasing the axial thickness of the member, while it is readily increasable when the exterior diameter of the annular disc member is increased. In practice there is plenty of free space about the voice coil, and even though the magnet material compared with the alloy materials is generally less effective per volume unit, a fully satisfactory magnetic effect has then nevertheless been obtainable with the use of a relatively thin annular disc member showing a large material volume by virtue of a relatively large outer diameter.

With the use of e.g. a glueing technique these magnets may be placed as spacer and anchoring elements between the rear pole discs and the exterior annular front pole members of the magnet systems, while the central rod members thereof are constituted by short rods of soft iron. Such a design is advantageous in that the magnet system is easy to assemble into a self-carrying unit which may be joined to the loudspeaker diaphragm carrying chassis solely by fastening the same to the exterior front pole member of the magnet system. For loudspeakers of a given voice coil diameter a system of this type is characterized by a short building length or depth, but also by presenting an exterior magnetic field; an effective magnetic shield cannot be provided immediately outside the magnetic system, because this would imply a magnetic short circuit and therewith a decreased magnetic flux in the air gap of the voice coil adjacent the central hole of the magnet.

During the last few years the price of the cobalt based alloy magnets has gone up to such a level that generally these magnets are no longer usable in commercial loudspeakers, and in practice, therefore, it is necessary to make use of the said ferrite type magnet systems, even where the exterior magnetic field of these systems is recognized to be disadvantageous, e.g. in television receivers.

It is the purpose of this invention to provide a loudspeaker, the magnet system of which is designed such that with the use of a cheap magnet material it will show both a good magnetic flux in the air gap of the voice coil and a short building length or depth, without being complicated and even without showing any considerable exterior magnetic field.

According to the invention this is obtained by designing the loudspeaker as stated in the characterizing clause of claim 1. The invention is based on the cognition that in practice it is in fact perfectly possible to make use of a voice coil diameter which for a given loudspeaker size is so unusually large that the voice coil may surround a central magnet pole having a diameter of the same generally very large size as the exterior diameter of a conventional ferrite type ring magnet, whereby the cheap magnets of just this type will be directly usable as the central magnets in systems which are otherwise designed

principally just as the said systems based on a central magnet of the alloy type. Apart from the required unusually large voice coil diameter this design will involve a combination of the advantages of the said two basic types of magnetic systems without their said respective disadvantages. Of course, the normally essential central hole in the ferrite type magnet will hereafter be without particular importance, but if desired it may well be retained, whereby conventional ring disc magnets are usable with the invention without any kind of adaption.

The said unusually large voice coil diameter has proved to be fully acceptable, and in several respects it is even advantageous, e.g. in woofers. In commercial woofers it has been a problem that the desired large voice coil diameter gave rise to a very large and heavy exterior magnet of the disc ring type, and the invention solves this problem by the central mounting of the flat magnet disc.

It could be feared that the magnetic flux in the cylindric air gap would be reduced to an unusable degree when the air gap is located adjacent the outer periphery of the disc magnet rather than adjacent a central hole therein, but even though the flux per length unit of the gap is reduced the total flux is nevertheless sufficient to condition a fully satisfying operation of the loudspeaker. The increased diameter of the voice coil involves an increased weight of the coil, and this, of course, will imply that the voice coil of a loudspeaker according to the invention should be made as light as possible, e.g. by its coil consisting of aluminium wire rather than copper wire.

Another and very important advantage of the generally increased voice coil and air gap diameter is that the heat generated in the coil is easily let away from the coil, i.e. the loudspeaker may in practice operate with a relatively very high electrical effect.

A further important advantage is derived from the combined use of a magnet system of short axial length and no external magnetic field; such a system may be housed in a closely surrounding iron cup member, and such a cup member may be constituted by a rear cup pressed portion of the diaphragm holding loudspeaker chassis, whereby it is very easy to prepare the chassis for receiving the magnetic system in a truly centered position. When the side wall of the cup portion consist of iron the magnetic system will hereby be still further shielded towards the surroundings.

In the following the invention is described in more detail with reference to the accompanying drawing, in which:—

Fig. 1 is a sectional view of a known loudspeaker of the ring magnet type,

Fig. 2 is a corresponding view of another known loudspeaker of the central magnet type,

Fig. 3 is a corresponding view of a loudspeaker according to the invention, and

Fig. 4 is a corresponding view illustrating modifications of the system according to Fig. 3.

In the known loudspeaker shown in Fig. 1 a base disc 2 is provided with a protruding central rod 4 and a protruding cylindric element 6 on the outer end of which is mounted a pole disc 8 having a central hole into which the front end of the rod 4 projects so as to define an annular air gap 10. A voice coil 12 connected with a loudspeaker diaphragm 14 projects into this gap. To the pole piece 8 is riveted a generally conical carrier chassis 16 serving to hold the outer edge of the diaphragm 14. In this known system the permanent magnet is constituted by the cylindrical element 6 which is traditionally a relatively flat and wide ring member of ferrite, which is a reasonably cheap and effective magnet material. The magnet system however, shows the characteristic and in some connections undesired feature that a magnetic field exists on the outside of the system, between the outer edges of the pole pieces 2 and 8. Normally these pieces are glued to the magnet 6, whereby the magnet system is a self carrying unit showing a relatively short building length.

Fig. 2 shows a younger design in which the exterior magnetic field is eliminated. Principally the elements of the system are the same as in Fig. 1, though a pole disc 18 is here mounted on the free end of the rod 4. The difference is that in the design of Fig. 2 it is the central rod 4 which is the permanent magnet. The mass of this magnet is considerably smaller than that of the ferrite ring member 6, and historically the use of the central rod magnet was made possible with the occurence of magnetically very powerful alloy materials of the Alnico-type, i.e. magnet materials based on cobalt. Therefore, despite a relatively high price of the Alnico-material it was possible to use these materials in practice because of the reduced amount of material necessary for the central rod 4 as compared with a cylindric ferrite member. In Fig. 2 the magnetic field is concentrated in the magnet system and in the air gap 10, and an exterior field is practically eliminated, whereby the loudspeaker is usable e.g. in television sets without any disturbing effects of an exterior magnetic field. Normally, however, the building length of the magnetic system will be larger than in Fig. 1.

Unfortunately, the price of the highly effective alloy magnet materials on cobalt basis has increased to such a degree that it is no longer practically possible to use the design of Fig. 2 for loudspeakers to the ordinary consumer's market.

According to the invention use is made of a relatively wide and flat cylindrical member of ferrite or a similar cheap magnet material, but this magnet member (whether or not provided with a central hole) is used as the central "rod" member in a system in which the exterior cylindric member is a passive magnetic flux conductor to the air gap area, i.e. the basic design will be similar to Fig. 2, though with the center rod 4 replaced by the wide magnet element 6 of Fig. 1 and — in a highly untraditional manner — with the annular air gap being located adjacent the outer periphery of the ring member 6 of Fig. 1 rather than adjacent or inside a central hole therein.

Fig. 3 of the drawing is a sectional view of a loudspeaker according to the invention. The cylindric member 4 is an ordinary flat ferrite magnet, though it need not show any central hole. The front pole piece 18 is of an external diameter slightly larger than that of the magnet 4, and the rear pole disc 2 is provided with the exterior cylinder 6 as an integrally formed edge portion thereof, though of course the cylinder 6 may be a separate element. The air gap 10 is formed between the outer periphery of the pole disc 18 and the inside of the front end of the cylindric portion 6. It will be noted that the diameter of the voice coil is considerably larger than traditionally as illustrated in Figs. 1 and 2. The system may be of short building length as in Fig. 1 and be without any external magnetic field as in Fig. 2.

The magnet system of Fig. 3 is well suited to be mounted in a cup member 22 which may form part of the cone structure 16. In a preferred embodiment the cone structure 16 is made of pressed sheet iron with the cup portion 22 as an integral part thereof, and it is obtained hereby that the magnetic system is extremely easy to mount in a centered position in the cone structure. Another important advantage is that the cup and cone structure provides additional magnetic shield to further reduce the exterior magnetic field.

The members 2, 4 and 18 may well be provided with central holes, as shown partly in dotted lines, and through these holes may extend a central, non-magnetic holding rod member. Alternatively the hole may be used for venting, or a vent passage may be provided in said holding rod member.

When a disc magnet 4 is used in which the conventional center hole is retained it will be possible to utilize it in a loudspeaker design in which, as in Fig. 3, the outer periphery of the magnet disc cooperates with a large voice coil 12, while the hole of the magnet is used for additionally cooperating with a small voice coil as in Fig. 1, whereby the latter voice coil may drive e.g. a tweeter dome or diaphragm, the outer periphery of which is fixed to the front side of pole piece 18 which should then be an annular disc member. In that case the central diaphragm portion 14 in front of the large voice coil 12 should be removed or be perforated.

It will be appreciated that the short building length of the magnet system according to Fig. 3 will enable the cup member 20 to be made as a pressed cup member of a reasonably thick iron sheet material.

For the same reason it is relatively easy to provide the cone chassis 16 with the said rear cup portion 22 for receiving the magnet system in an accurately centered position. Hereby is additionally obtained a very "clean" and attractive appearance of the rear side of the loudspeaker, and the cylindric wall of the cup portion 22 will serve as a further exterior magnetic shield for the magnet system. The flat bottom portion of the cup member 22 may be provided with a large central hole.

In the alternative embodiment illustrated in Fig. 4 the outer annular portion 6 of the magnet system is shaped with an outwardly arched cross section, whereby the magnetic flux may advantageously be guided through material portions having no sharp bends. The cone chassis 16 may be secured to the magnetic system by means of a cup or collar portion 22 as described above and shown in the upper half of Fig. 4, or by being riveted to the outside of the portion 6 as shown in the lower half of Fig. 4. The disc magnet 4 as used in Fig. 4 is not provided with any central hole.

The relatively very large diameter of the voice coil 12 and the corresponding air gap confining material portions will condition a high cooling effect on the voice coil, and in practice a loudspeaker according to the invention can be expected to resist at least twice the electrical maximum loud compared with a conventional loudspeaker according to Fig. 1 or 2. This is extremely important, because in the modern development of audio reproduction equipment it is desired to use loudspeakers of high electrical effect. The invention enables these demands to be met by a loudspeaker of simple design, low price and yet high reproduction quality.

Typical dimensions of the disc or ring disc shaped magnet will be a thickness of 10—40 mm and an outer diameter of 70—130 mm for example a standard magnet of thickness 17 mm and outer diameter 92 mm.

It will be understood that the invention resides in the use of disc shaped central magnet members of a character which would otherwise predestinate them, according to the known art, to be used as annular magnet members about the voice coils, and generally the invention comprises the use of a pronounced flat disc shaped magnet as the central element of the magnet system and the associated use of an unusually large voice coil.

It should be mentioned that the loudspeakers in question will normally be of the type in which the voice coil is longer than the axial dimension of the air gap, i.e. so as to project substantially out of the air gap to both sides thereof. Moreover, as used conventionally in loudspeakers, the inner end of the diaphragm should preferably be radially stabilized in an axially movable manner by means of a surrounding collar sheet member, the outer edge portion of which is secured to the loudspeaker chassis, but it is deemed unnecessary to illustrate in the various figures this very conventional feature.

It will be appreciated that the manner in which the magnet system is received and centered in the rear chassis portion according to Fig. 3 is very advantageous, because a correct centering is very easy to accomplish. The magnet system may be secured to the inside of the depression 22 by means of glue, rivets or otherwise. The magnet system according to the invention is particularly well suited to be mounted in this manner, but the advantage as to the centered mounting as such is not limited to any particular design of the magnet

system, except that at least a portion of the system should be shaped so as to be receivable in the depression in a self centering manner.

CLAIMS

1. A loudspeaker having a diaphragm and an associated voice coil arranged in a cylindric air gap in a permanent magnet system, which comprises a rear pole member and a central part and an outer annular part projecting substantially concentrically from said rear pole member, the air gap being formed between the outer ends of these parts or pole members thereon, characterized by the combination of the magnet system being of the type in which the permanent magnet is constituted by a substantially disc shaped magnet body, normally of a material of the ferrite type, and this magnet being mounted as the said central part, the voice coil having such a large diameter that it may surround the outer, substantially circular periphery of the magnet disc body, while the said outer annular part as known per se is of the soft iron type.

2. A loudspeaker according to claim 1, in which the magnet body is a standard ferrite magnet provided with a central hole.

3. A loudspeaker according to claim 1 or 2, in which the rear pole member and the outer annular member are formed integrally as a cup member of soft iron material.

4. A loudspeaker according to claim 1, 2 or 3, in which the outer periphery of the loudspeaker diaphragm is fixed to a conical loudspeaker chassis to which the magnet system is secured in a centered position, characterized in that the magnet system is received in a rear cup shaped depression in the rear central part of the loudspeaker chassis.

5. A loudspeaker according to claim 4, in which the loudspeaker chassis is made of a magnetically well conductory material.

6. A loudspeaker substantially as herein described with reference to and as shown in the accompanying drawings.

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